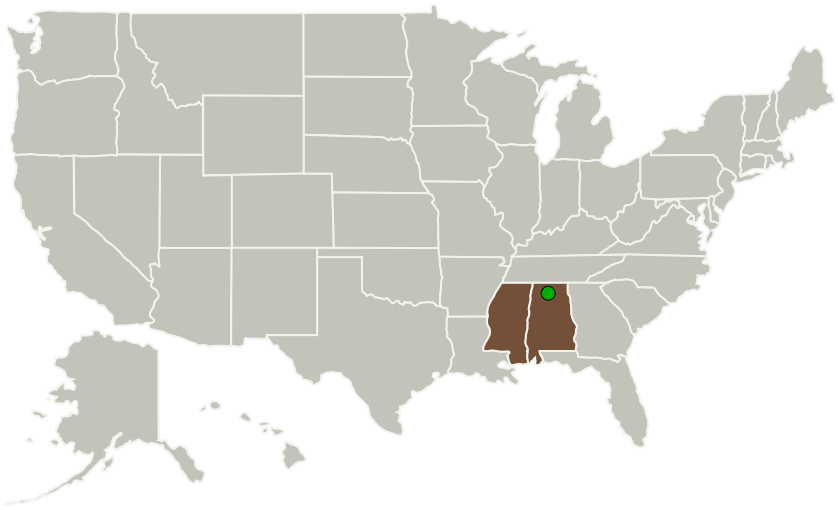
Unified In-Space Propulsion Framework for Prediction of Plume-Induced Spacecraft Environments, Phase I

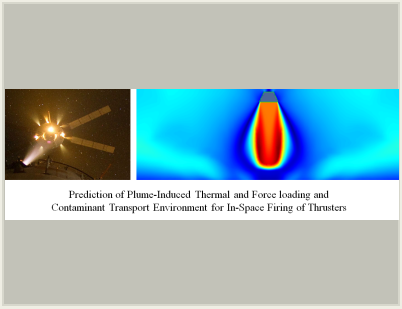
Completed Technology Project (2016 - 2017)

Project Introduction

Chemical contamination of spacecraft components as well as thermal and force loading from firing liquid propellant thrusters are critical concerns for in-space propulsion applications. Gas molecular contamination and liquid droplet deposition due to incomplete combustion threaten to damage surface materials, sensitive instruments and optical sensors, and poses major risks for mission success. Liquid propellant thrusters operate in space at near-vacuum conditions, and contaminants traverse a complex mixed continuum-rarefied environment upon exiting the thruster nozzle. Current CFD modeling capabilities for in-space propulsion analysis have made great strides, but fall short of providing the fidelity required to simulate the contaminant transport around the spacecraft with sufficient efficiency and accuracy. This STTR will develop and deliver an innovative computational architecture for prediction of plume flow impingement and contaminant dispersal through mixed flow environments for in-space propulsion analysis. CFDRC will supplement the massively parallel Loci framework with a highly accurate unified solver for prediction of mixed continuum-rarefied flows with contaminant dispersal. This will enable better understanding and prediction of thermal and force loading and contamination of spacecraft components, and enable design of a new era of safer next-generation in-space propulsion systems. Phase I will demonstrate improved modeling fidelity and provide great insight into in-space thruster plume contaminant environments. Phase II will bring the complete predictive capabilities to production for detailed investigations into contaminant environments for full spacecraft configurations.

Primary U.S. Work Locations and Key Partners





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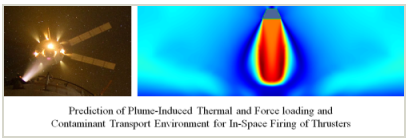
Completed Technology Project (2016 - 2017)

Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Mississippi

Images



Briefing Chart Image
Unified In-Space Propulsion Framework for Prediction of Plume-Induced Spacecraft Environments, Phase I
(https://techport.nasa.gov/image/135665)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
CFD Research Corporation

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Ranjan Mehta

Co-Investigator:
Ranjan Mehta

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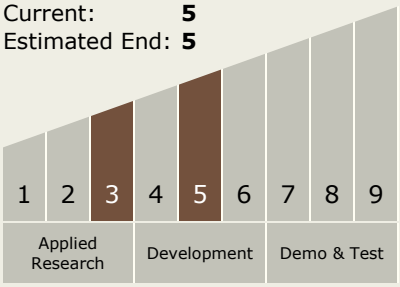
Completed Technology Project (2016 - 2017)

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.2 Earth Storable